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## Working Towards Information Superiority: Application Coherence for Digitisation Programmes – A Method for Coherently Defining Requirements for Future Command and Control Information Systems

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### **ABSTRACT**

*Within the UK, a conceptual model has been developed which represents the main processes of the Army, i.e. the Army Activity Model (AAM). It predominantly illustrates information dependencies between processes and information elements that are exchanged between them. Over the last 18 months, the AAM has significantly matured. Moreover, there is a better understanding of its relevance for current and future Information Systems. A methodology has recently been developed that enables the richness of the AAM to be exploited for developing new C2 Information Systems (IS). By using this methodology coherent development and definition of user requirements can be achieved. In addition, the methodology enables, albeit at a high level, the assessment of coherence between C2IS and, more specifically, the processes and information that these systems support.*

*Using a UK Case Study based on the development of a Joint Fire Support (JFS) Battlefield Information System Application (BISA), it is explained how the methodology allows the use of the AAM for development of new CCIS. It is explained how various Soft Systems Methodology (SSM) and Modelling techniques helped to relate the JFS BISA to the AAM and define or validate coherent user requirements. Using the AAM, application coherence can be assessed and visualised at both informatics as well as technology levels. Although such assessments are conducted at a high level, they nevertheless provide detailed information on gaps and overlaps in the definition of IS requirements. This information could be used to improve requirements definition and aid coherent and interoperable system development. Finally, the paper will attempt to contrast the application coherence method with the COBP.*

**Key Words:** Command and Control Information Systems, application coherence, soft systems methodology, information superiority, requirements derivation.

### **1.0 INTRODUCTION**

There is a danger of misalignment between applications and the businesses they purport to support and, through a lack of strategic direction, a risk that bespoke and stovepipe Information System (IS) development will continue. There is concern that there is a potential lack of coherence across, and within, Battlefield Information System programmes. Not only may this result in an inability to transfer data and information effectively between battlefield applications, it will seriously degrade the ability to exploit information and will impede the achievement of information superiority.

Within the UK, a conceptual model has been developed which represents the main processes of the Army, i.e. the DINF(A) Army Activity Model (AAM) – which has been presented at previous editions of this

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Symposium. It has been explained that the AAM predominantly illustrates information dependencies between processes and sub-processes, and information elements that are exchanged between them. Over the last 18 months, the AAM has significantly matured. Moreover, there is a better understanding of its relevance for current and future Information Systems. A methodology has recently been developed that enables the richness of the AAM to be exploited when developing new Command and Control Information Systems. By using this methodology coherent development and definition of user requirements can be achieved. In addition, the methodology enables, albeit at a high level, the assessment of coherence between C2 Information Systems and, more specifically, the processes and information that these information systems support.

This paper explains how the methodology allows the use of the AAM for development of new CCIS. Using a UK Case Study based on the development of a Joint Fire Support (JFS) Battlefield Information System Application (BISA), it is explained how various Soft Systems Methodology (SSM) and Modelling techniques helped to relate the JFS BISA to the AAM and to define coherent user requirements. It is also explained that this approach enables coherent development of system requirements. Moreover, the paper will explain how, through the use of the AAM, application coherence can be assessed and visualised at both informatics as well as technology levels; this method is known as COVIS i/t. Although such assessments are conducted at a high level, they may nevertheless provide detailed information on gaps and overlaps in the definition of Information System requirements, especially with regard to the processes they are to support. This information could be used to improve requirements definition and aid coherent and interoperable system development. Finally, the paper will attempt to contrast the application coherence method with the COBP.

## **2.0 ANSWERING THE CHALLENGES OF DIGITISATION**

### **2.1 The Information Age**

Through history, societies have been confronted by continuously improving military technology and the challenge to innovate their defence systems. Evidently, nations need to cope with new threats and prepare accordingly. Nevertheless, history also shows that nations – especially when experiencing times of great prosperity – may be tempted to discontinue their investments especially when the belief increases that conflicts can be resolved in other ways. In the 3<sup>rd</sup> Century BC, when discussing the necessity of walls around cities, Aristotle (1992), in pointing to ‘modern improvements in the accuracy of missiles and artillery for attacking a besieged town’, already warned for the potential catastrophe of omitting strong walls. That the intention of this ancient advice has not lost its significance is underlined by the current geo-political situation.

Militarily, we are now facing the challenges of ‘information-age warfare’; many NATO Allies are currently implementing a digitisation programme in some form or shape. It is commonly envisaged that armed forces can be transformed into a smoothly operating synchronised system, very like a fine tuned machine. Behind this idea is the fundamental assumption that the friction of warfare will be automatically ameliorated or eliminated by effective acquisition and transmission of information that has been transformed into appropriate command knowledge. By effectively using information, armed forces will be able to move quickly and attack an enemy simultaneously in multiple dimensions, overwhelming the opposing side’s ability to control operations and to frustrate ‘our’ objectives; moreover, it is believed that by mastering information, operations can potentially be commanded at an operational tempo that no potential enemy can match (PAM, 1994). The concept of information superiority seeks to ensure that the peacekeepers and warfighters receive the right information at the right time to optimally influence the outcome of an operation.

However, with the focus on an ‘information centric’ approach, the development and introduction of command and control or battlefield information systems faces many challenges of which some have long

been known while others have only recently emerged. Traditional system development and engineering methods no longer suffice while for operational analysis – as is highlighted in the NATO Code of Best Practice (COBP) for Command and Control assessment – more qualitative methods and techniques need to be embraced. An evolutionary relationship exists between the methodologies and techniques used to define requirements, to design and develop the system and to assess its operational effectiveness. Therefore, it could be argued that if these methodologies and techniques were to be adopted in the requirements, design and development stages of new systems they could in turn alleviate some of the shortfalls of operational analysis. In the following paragraphs some of the issues associated with digitisation and related to characteristics of organisations, information, and information systems will be highlighted, which underpin the necessity for a novel approach.

## **2.2 The Need for a Different Approach**

In '*Vom Kriege*' von Clausewitz (1982) explains that information is the knowledge one possesses of the enemy and his land, and that this constitutes the foundation for all our own ideas and actions. He warns that when considering the nature of this foundation, especially the unreliability and changeability thereof, it rapidly becomes clear how dangerous and fragile the framework of warfare is and how it could bury us under its rubble; information or intelligence during wartime is contradictory, an even larger portion incorrect and the largest part extremely dubious. Scholars from other fields of expertise, such as the public administration and political science, have found that information during crisis situations can be confusing, untrustworthy, incomplete, inaccurate, et al. 't Hart (1993) highlights that during crises decision-makers face both information 'underload' as well as overload. It is hardly sufficient to conclude that with digitisation, or the development and implementation of information systems and technology that support the conduct of warfare, we are facing some complicated issues. Albeit tempting, these issues cannot be resolved by engineering alone nor by simply introducing hardware and software.

Nevertheless, as is highlighted in the NATO COBP (2002), the focus of military research has predominantly been on the physical domain. It is further stated, that because Command and Control deals with distributed teams of humans operating under stress and in a variety of other operating conditions, Command and Control problems are dominated by their information, behavioural and cognitive aspects, which are less well researched and understood. As is highlighted by Checkland and Holwell (1998), organisations are often seen as goal-seeking machines where individual decision-making occurs to achieve these goals. However, from an information aspect system such a view is too limited. Traditionally, engineering, development and design approaches have not embodied the kind of in-depth exploration of organisational thinking which is necessary if information requirements are to be richly captured. They argue that a change of focus from data processing towards people and processes which the system serves and supports would then be necessary. Inevitably, in the goal-seeking organisation, like a machine, people are seen as automatons that will deliver *sine qua non*. In contrast, real organisations are characterised by permanent debates about aims and how best to achieve them and are staffed by real people whose perceptions of the world never coincide exactly, and certainly not with any notional worldview which is that of the abstraction 'organisation'.

In '*Trapped in the Net*', Gene Rochlin (1997) points to the unanticipated consequences of an ever increasing computerisation and the introduction of more and greater computing power. Using examples such as the case of USS Vincennes and the shooting down of the Iranian airliner, he explains that many of these consequences have a human or organisational origin. Moreover, the organisation that introduces, or improves its existing, information system technology should not ignore the fact that the way in which it operates may be altered significantly and to such a point that cannot be imagined up front. Checkland and Holwell (1998) highlight that at an operational level new technology would bring changes to the design process and working practices would be changed. With the introduction of a new information system not only the organisation, but also its agents and technology will be changing individually and while at the same time affecting each other. If the organisation is to absorb the technological, organisational and

social changes successfully, it should consciously conceptualise these elements and their interactions as a 'whole'. Using merely a 'hard' approach and solution would ignore these and it would remain questionable – the least – whether such a solution would ever be effective. Wilson (1990) highlights that organisations, rather than dealing with 'how' to solve a problem, firstly should concern themselves with determining 'what' the problem is. The 'spiral development' methodology applied in the Task Force XXI programme recognises that new technology might potentially effectuate changes to doctrine, organisation, et al. In turn, these changes might shape and steer further development.

Worm (2001) highlights that 'adequate performance in complex, high-risk, tactical operations requires support by highly capable management'. He states that 'commanders and senior decision-makers must manage true real-time properties at all levels: individual, stand-alone technical systems, high-order integrated socio-technical systems and forces for joint operations alike'. Measuring performance, developing systems and conducting operational testing that cope with such complex conditions are a challenge. Moreover, Command and Control, tactics, techniques procedures and training are forced to constantly and concurrently strive for perfection. However, as is stated by Worm, this is beyond reach unless novel cutting edge solutions can support the humans and systems engaged.

Digitising armed forces is like transforming them into a smoothly operating system, which requires traditionally disparate elements to be linked or networked into one single whole, or a system of systems. The desire to do more with less is a major factor driving this transformation. Consequently, much of the slack in a traditional army will disappear, while operations are sustained by just in time logistics processing. The availability of information technology will give senior commanders a real-time 'god's-eye' view of the battlefield and enable them to plan, task and execute operations. To respond dynamically to developments on the battlefield, communication lines may pervade the more traditional hierarchical structures. Most armies have never experienced such significant organisational changes as introduced by digitisation. From an organisational perspective it is not only paramount that the complex myriad of systems is not only capable of sharing and exchanging information between systems, as has been the traditional focus, but also support the processes of the organisation in a coherent manner.

There is a growing realisation that a meticulously planned, integrated command and control information infrastructure is desirable. Information integration provides the mechanisms to transform data into information and information into knowledge. However, there is a danger that as a result of decentralisation of acquisition processes and a lack of co-ordination between programmes, infrastructures, communication systems and networks may be inadequate to support the information enterprise. Beckner (2000) highlights that communication systems and networks are inadequately managed because the information needs of the users are poorly defined. Over the past few years much effort has been devoted to develop C2 and information architectures that define relationships between entities, their information systems and exchange mechanisms. The main goal of an information architecture is to define for its components 'what is needed', 'when it is needed' and 'how to interface'. The US C4ISR Architecture Framework is proof that the value of architecture products to define present and future needs is realised. However, as is highlighted by Breckner (2000), despite this architecture framework a major challenge remains in focussing on information content and use. Moreover, although much is done to assess architectures, e.g., their effectiveness, this remains a complex task. Often architectures are incomplete in that certain products do not exist and creating them especially for large architectures may not be a realistic option (McBeth, 2000). Consequently, there is a risk that the apparent inadequacy of these architectures may fail to resolve some of the intricacies of defining and developing new systems.

### **2.3 Soft Systems Methodology**

The issues discussed above represent some of the major challenges of digitisation. It has been highlighted that the problem situation is complex and that a route to a solution would need to embrace organisational, human and technological aspects. Major challenges exist in that the information needs of users are poorly

defined. Yet, information is a commodity whose timeliness and use is paramount to success between operational nodes at every level of every organisation (Beckner, 2000). C2 and information architectures help to define current and future information needs and have therefore helped to ameliorate the situation. Unfortunately, architectures still lack a focus on information content and use. Soft systems methodology (SSM) offers a way to make sense of such complicated problems and adopts an information centric stance, while including human issues from the outset.

SSM, itself is a method for resolving problems and assists in understanding the many simultaneous views which may exist on what an organisation is trying to achieve. This allows potential interfaces to a system and factors that influence system implementation to be investigated thoroughly. SSM is particularly useful where business requirements are unclear, conflicting interests exist, or the proposed system is contentious. Moreover, SSM may be applied to good effect where changes to business processes or organisational structure are likely (CCTA, 1993). SSM is based on the premise that information systems exist to serve and support people taking purposeful action. This purposeful action can be expressed via activity models, to which SSM terminology refers to as 'Human Activity Systems' (Checkland and Holwell, 1998). Checkland and Scholes (1999) explain that SSM offers a process through which an organisation can continually reflect upon its aspirations and tasks, thus continually reviewing its information strategy; using the methods of SSM activity systems could be modelled and the models used in a design mode to ensure that processes are institutionalised by means which the organisation would continue to learn from its flow of experience. It is noted, though, that SSM may be used to complement other approaches, e.g., SSADM and System Dynamics, rather than replacing them. The advantage of applying SSM is that it encourages the analysts to concentrate on the business environment, while considering the area under study in the context of the whole organisation and acknowledging multiple perceptions of which some may conflict. The UK Army has been successfully using SSM techniques to construct coherent views of its processes and the information dependencies between them. From the initial modelling activities an approach has now emerged to assess whether and how existing and future information systems support the processes of the Army information enterprise. This method, referred to as 'application coherence' (Hi-Q Systems, 2001) is explained in the following paragraphs.

### **3.0 APPLICATION COHERENCE**

It is thought that there is poor alignment between processes and the supporting applications and little coherence between the numerous planned and in-service information. This can be attributed to, albeit in part, a lack of definition in the underpinning information architecture, against which an information strategy can be defined, and a lack of clarity regarding application and process propensity. However, it will be argued that the development of information systems could be rationalised by focussing on information and application coherence, which would improve resourcing efficiency, enhance operational effectiveness, and improve information exploitation.

Addressing applications coherence is a complex, multifaceted system of problems. The problem of improving application coherence is not one of software integration, but one of developing and maintaining an information view of processes, applications and their inter-relationship. The starting point is to take a view of the Army 'business'<sup>1</sup> and divide that into a coherent set of 'business areas' (see Figure 1).

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<sup>1</sup> The term 'business' has been selected as a neutral way of referring to a superset of purposeful processes supporting 'Army' and is, of itself, purposeful. A 'business' area is a further neutral term used to describe a smaller set of processes grouped together to achieve some particular purpose.

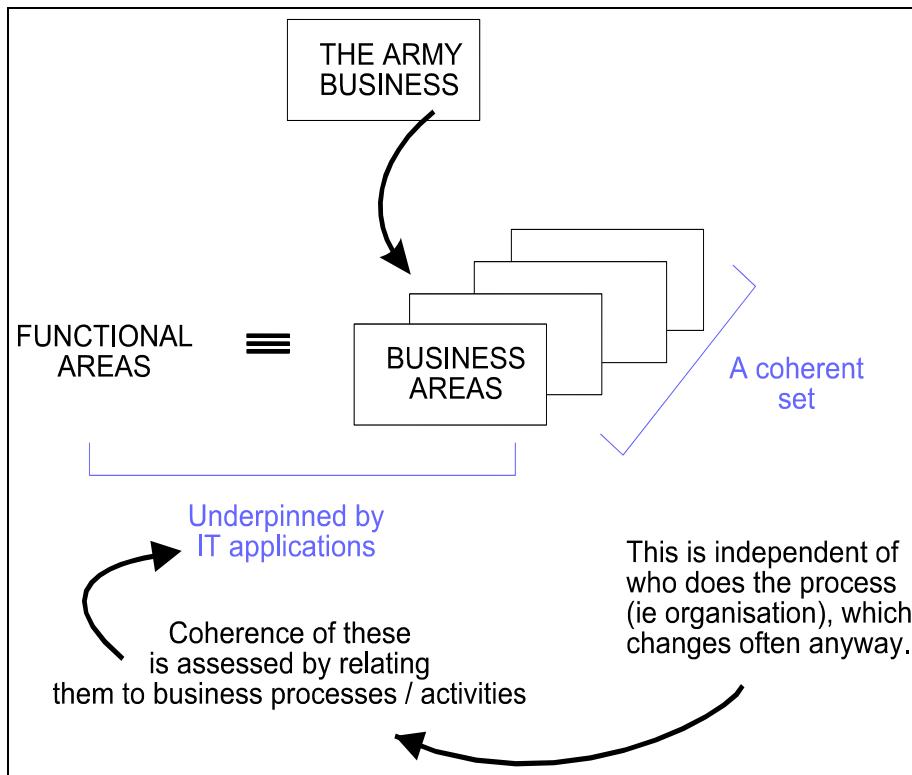
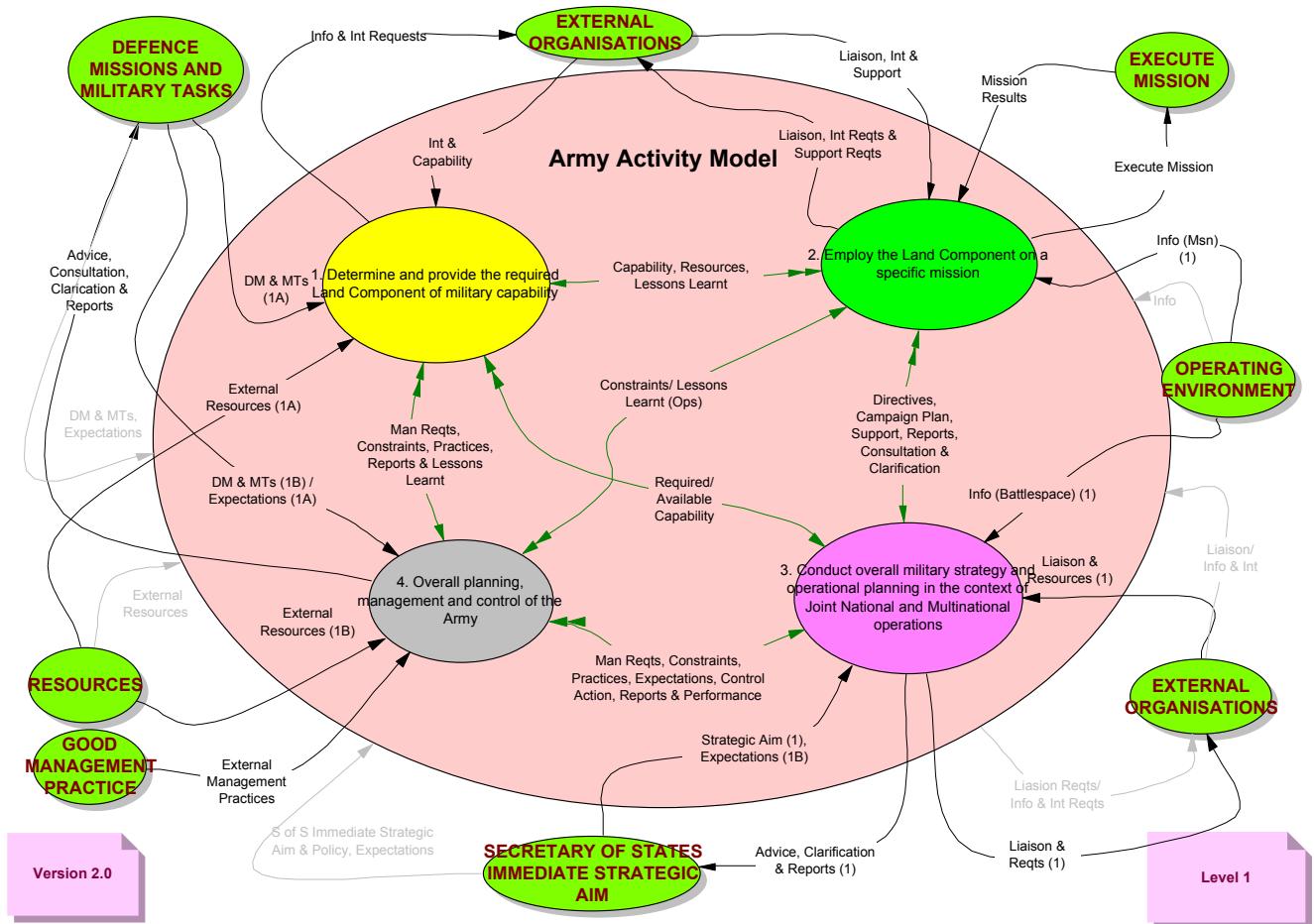


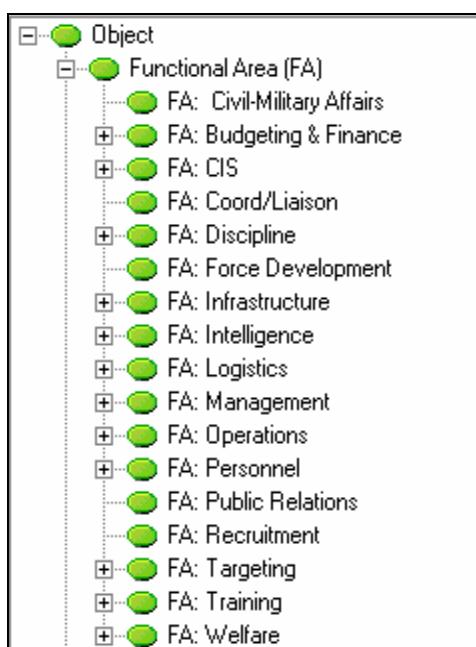
Figure 1: How to Assess Coherence.

Coherence of the business area set is important. A coherent view of process is traditionally delivered through an integrated business model. In the case of the UK Army/DINF(A), this is the Army Activity Model (AAM)<sup>2</sup>, (Figure 2) which defines business areas as ‘functional areas’ (Figure 3). The business or functional areas provide the ‘targets’ for coherence analysis, whilst aggregated, describing the whole Army ‘business’.

<sup>2</sup> The UK Army has developed a complete view of what it takes the Army ‘to be’ in the conceptual Army Activity Model which has been presented previously to this symposium as the Single Army Activity Model (SAAM) or Army Operational Architecture (AOA).



**Figure 2: Army Activity Model.**



**Figure 3: Functional Areas.**

Coherence is about synergy and is manifest in the identification of gaps and overlaps in target systems. Information driven analysis will identify these, both in the information available to support processes, and in the ability of applications to support information requirements. Gaps and overlaps in application coverage, individually or in sets, will also be evident.

At a high level of abstraction, an illustration of information analysis is shown in Figure 4. The figure shows, a business area, triggered by a real world problem, being analysed in terms of its supporting activities and the applications designed, or thought to, support it. The purpose of using a conceptual reference for processes is the certain knowledge that a set so derived is coherent. When conceptual processes are used, decomposition at the data level will, perforce, be informed by domain language. Activities and applications are analysed to reveal their information content referred to by the generic term ‘information object’. Refinement of this analysis shows that these ‘objects’ will need further categorisation into ‘information products’ (IPs) and ‘information categories’ (ICs). If associations between objects in these two lists are readily apparent, then the degree of correlation can be used in coherence assessment at this level. If the association is unclear, because of differences in semantics, then further decomposition of objects to data content and data sets is required. This continues until associations are clear. In addition, tests of coherence will be complemented by an assessment of technical interoperability criteria.

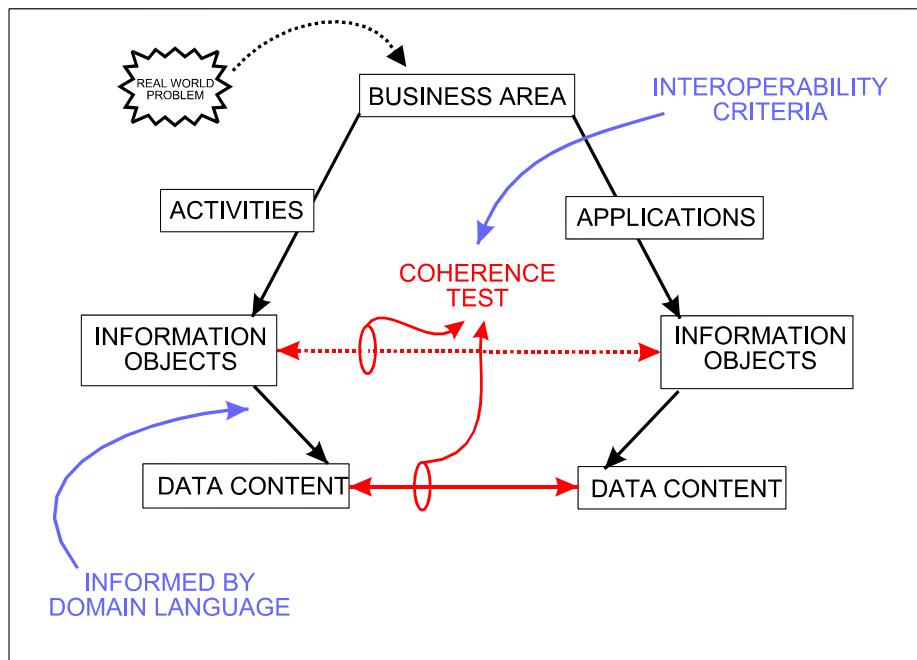


Figure 4: Illustration of Information Analysis.

In this paper, the term ‘information category’ refers to elements of information that need to be ‘known about’ in order to conduct a CP. The term ‘information product’ refers to the real-world IPs that are consumed by, and are produced by IS. These IS’ may be automated, that is hosted on a computer system, or may be hosted by a human. The fundamental hypothesis underpinning the coherence assessment method is that information categories derived from processes defined in a coherent process model when correlated with ICs contained in IPs derived from applications will inform the coherence assessment of an application set. Similarly, ICs derived from RWA will inform the coherence assessment for RWA. At a higher level, ICs contained in IPs consumed or produced by an organisation will inform the coherence assessment of an organisation.<sup>3</sup>

<sup>3</sup> It is, however, likely that IPs related to an organisation (ORBAT element) will be derived from the RWAs it conducts.

There is a warning associated with this type of thinking; it is only two-dimensional (process-information/application). Two disadvantages may apparent:

- a) Applications that pass the current test (in this case the criteria is ‘coherence’) may be chosen, rather than those ‘best of breed’.
- b) Changes to the information architecture become difficult since they need to be propagated and validated across all the applications and the business culture. One answer is to cluster applications. The AAM takes this sort of approach with its annotation of process and application with ‘functional area’ from a defined set. Each cluster is detailed and closely coupled (e.g., within ‘logistics’ or within ‘intelligence’), whilst coupling between clusters (e.g., between ‘logistics’ and ‘intelligence’) is weak. In a coherent solution, clustering should run from the business area right through the information model to the applications.

An organisational view is not essential to an assessment of application coherence but, nonetheless, may be allowed to contribute an important additional dimension. The ‘organisation’ is important in the design of a capability<sup>4</sup> because it provides influences through its size, its physical layout (an important factor in a dispersed battle-space for example) and the level of trust between its elements. In particular, organisation defines the relative scope of the configuration management activity and information/data management boundaries. ‘Organisation’ influences, and often seeks to control, the clustering of process and application. The software integration challenge will affect the feasibility and cost of coherence delivery. Coherence is also a function of the design of the IT applications and an assessment cannot be completed through the comparison of two information-based strands alone.

Combining the information-based assessment with technology related assessments would enable analysis to take a more substantial architectural approach. By attributing certain qualities to information exchange technology used by particular applications, systems or platforms it would be possible to create a more complete picture of the level and degree of coherence. The example below (see Figure 5) shows mapping of real world systems to the AAM processes through the mapping of AAM ICs with the applications’ IPs. By comparing the two RW applications it can be determined which processes and activities the two applications have in common. Subsequently, it can be assessed which IPs the two applications share that could support information exchange or could share provided that some translation or conversion (technological or procedural) would occur. In other words, although the applications perform or support similar processes it may not be possible to support information exchange other than through voice communication or swivel-chair translations. Finally, by assessing the particular interface hardware and software of each application and the available communication network it would be possible to determine whether technical connectivity can be achieved and whether limitations apply; for instance one application may be equipped with a different encryption device, or an application may only be capable of simplex data exchange, etc. The UK Army is currently undertaking further research into the development of a method that combines assessment of coherence at informatics as well as technology levels.

<sup>4</sup> Capability may be thought about as sets of process, resource and organisation. The role of organisation is to control the production and consumption of resource by process. Process holds purpose.

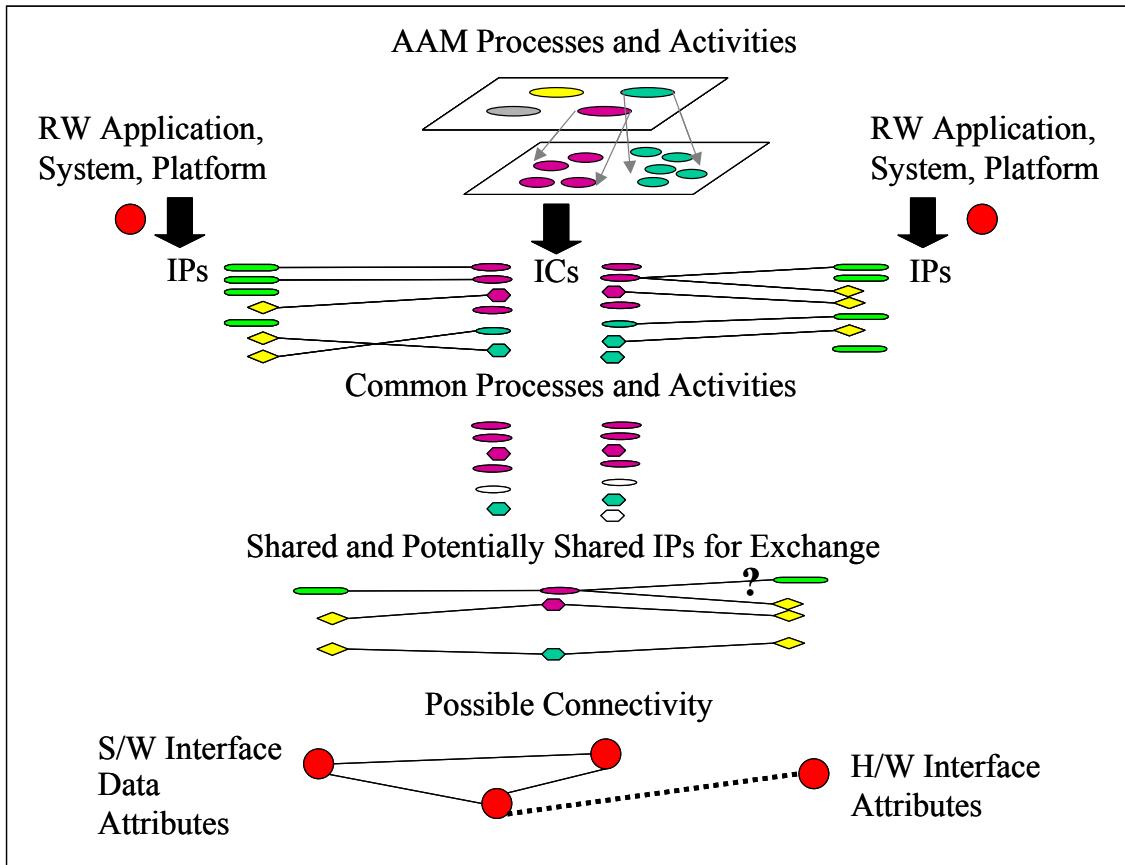


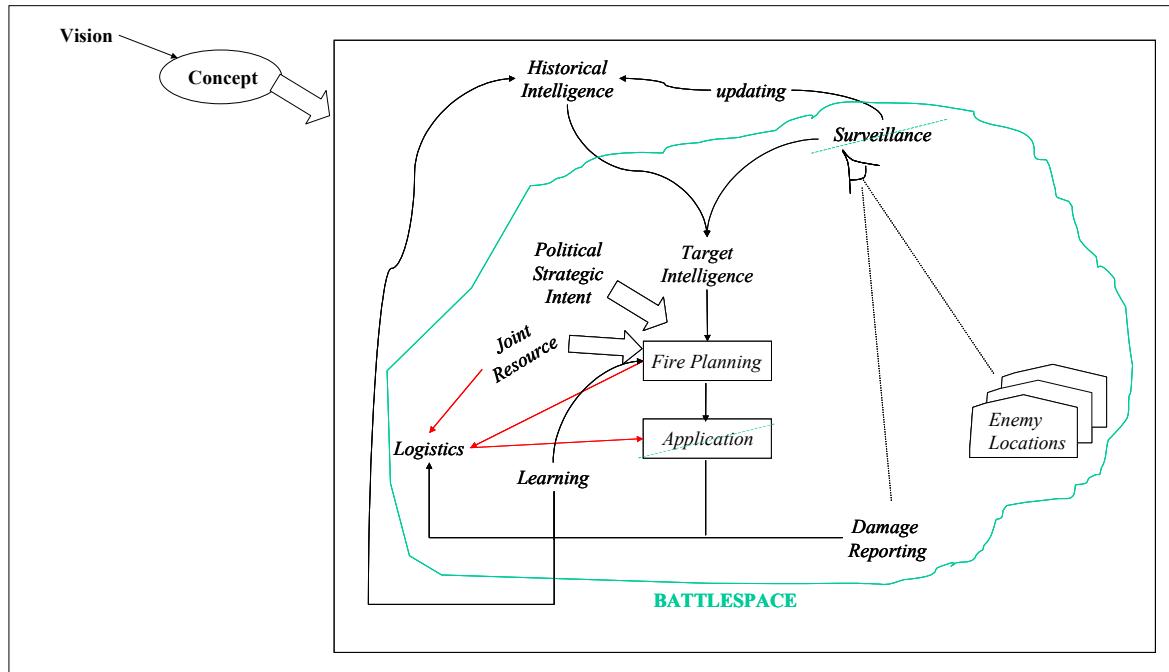
Figure 5: Assessing Coherence between Systems at Different Levels.

## 4.0 THE APPLICATION COHERENCE METHOD FOR NEW PROGRAMMES

### 4.1 The Joint Fire Support BISA Case Study

One of the UK Army's most recent programmes is the development of a BISA for Joint Fire Support (JFS). Early in the programme it was decided that the AAM would be of relevance to JFS and commensurate with the principles of application coherence, a method was sought which would enable the richness of the AAM to be used for JFS. It was decided that a number of activities had to be undertaken to capture the JFS requirements in such a way which would enable exploitation of the AAM. Various steps were taken to develop a conceptual model for JFS to analyse the degree of applicability of the AAM. The process model assembly has been achieved by applying various Soft Systems Methodology (SSM) techniques. The following paragraphs give a brief overview of the methodology describing the various phases that were adopted (Stage 1A, B and 2).

Based on the current understanding of Joint Fire Support (JFS) a conceptual template (Figure 6) for JFS was created, which was used for the planning of subsequent activities.



**Figure 6: Conceptual Template.**

The conceptual template is a generic, graphical representation of JFS and consists of its core internal and external processes and sub-systems. The conceptual template has been used to guide and capture the thoughts of specific stakeholders and assisted in focussing the information gathering and initial analysis. Moreover, it assisted in clearly defining the JFS boundaries and scope of the modelling activities. A plethora of information was available through visionary documents, study reports, Concept of Use documents, National, NATO and US joint and single service doctrines and tactical publications.

From the conceptual template, a Rich Picture (see Figure 7) and Root Definitions were created as consensual representations of processes relevant to JFS. It is noted that although these are the views of the analysts the stakeholders in particular and users' views have been accommodated and have been involved in the validation.

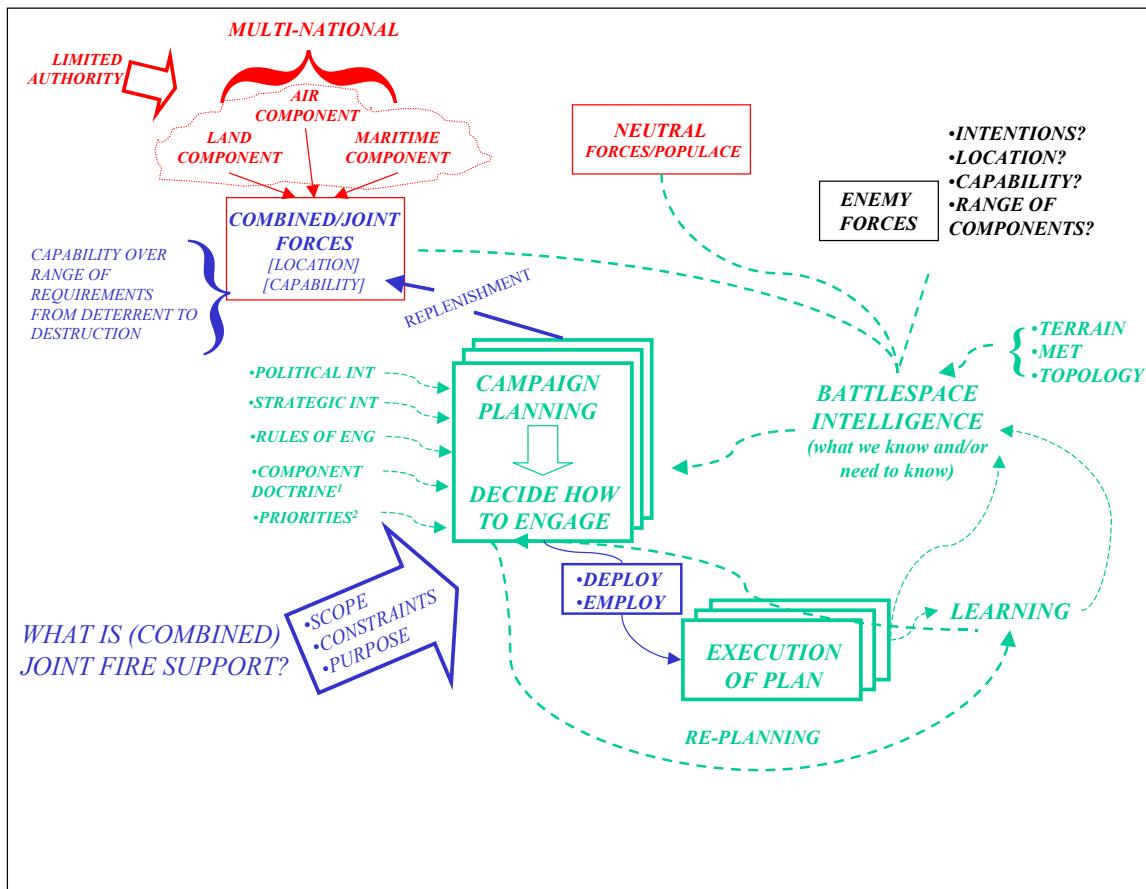
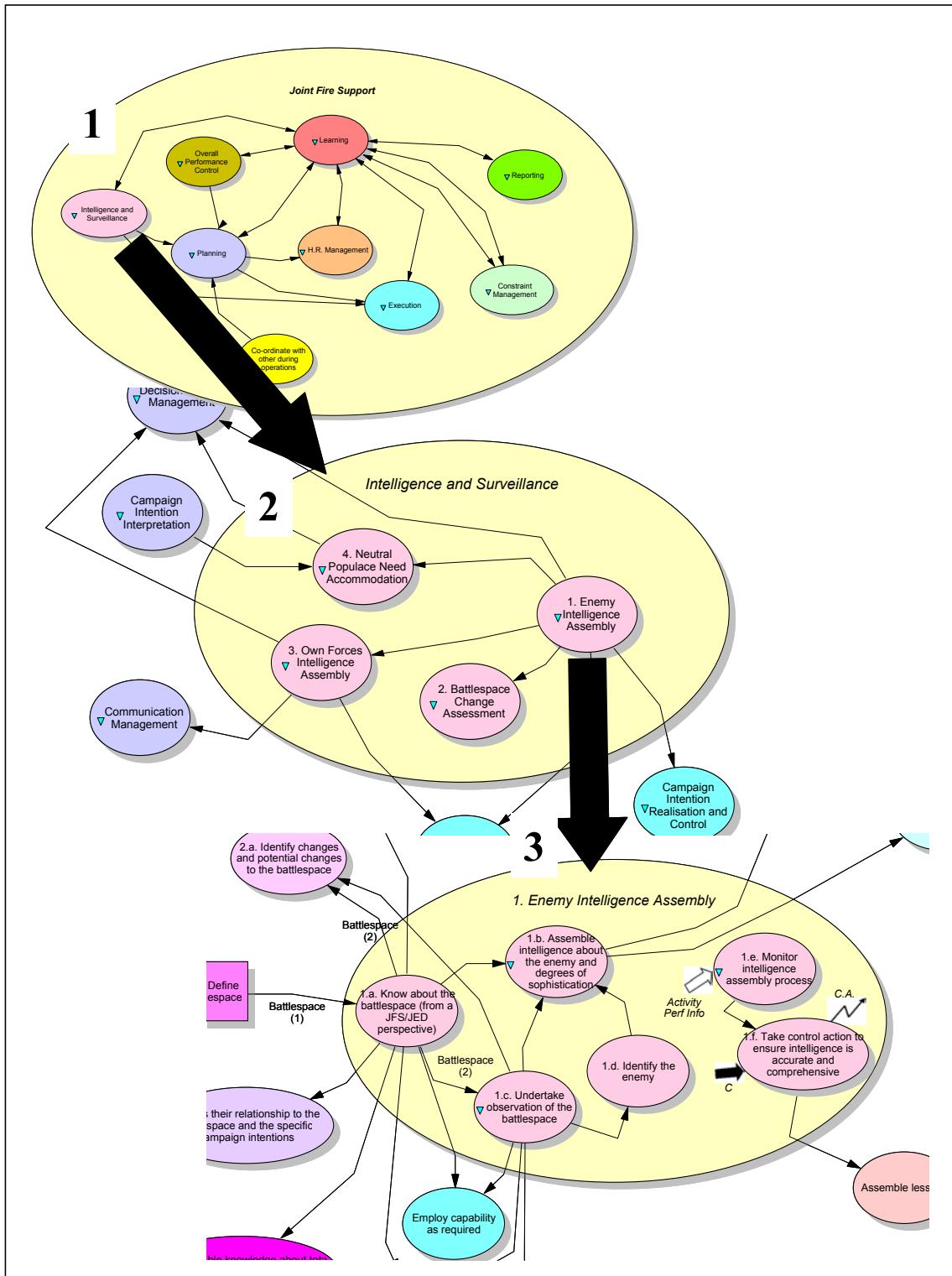


Figure 7: The Rich Picture.

The Rich Picture and the Root Definitions were then used to develop a conceptual model. In order to aid comparison with the AAM it was decided to keep the model larger in scope than JFS. The level 1 processes of this model and level 2 and level 3 examples are shown in Figure 8 below.



**Figure 8: JFS CM Level 1, 2 and 3 Processes.**

This conceptual model was then related to the Army Activity Model (AAM) to identify gaps and overlaps between JFS and the AAM, the latter containing the information detail and information dependencies as explained earlier. It was then possible to determine the degree of relevance of the AAM to JFS processes (see Figure 9).

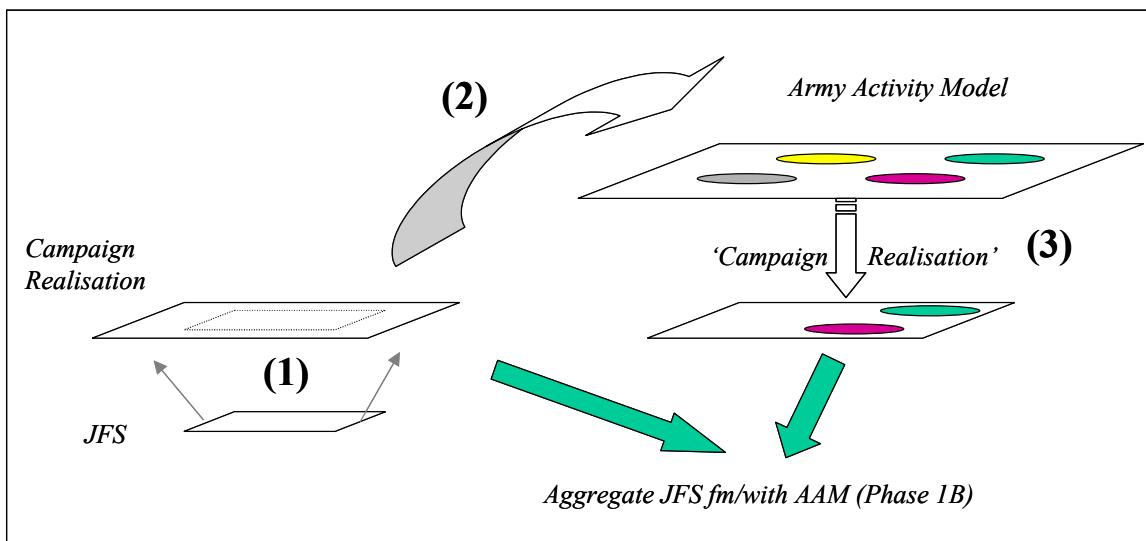


Figure 9: Using the CM to Determine the Appropriate AAM Processes.

Having followed this approach, a defensible and coherent JFS conceptual process model or aggregate model could be developed. Moreover, there was a perceived risk – as became apparent during the development of the application coherence assessment method – that certain processes in the AAM were themselves not coherently defined. Therefore it was decided that the intellectual process associated with the modelling activity had to take place independently of the AAM. Hence, this would mitigate the risk of incoherency caused by using inappropriate conceptual representations in the AAM. As a result of contrasting the generic/conceptual model with the AAM, future activities concerning the improvement of the AAM could also be identified. The AAM and the conceptual model were then combined to develop an enhanced process model relevant to JFS, which is available to for amendment and updating of the AAM.

The relationship between the various stages (Stage 1A, 1B and 2) is depicted in the Figure 10 below. Stage 1A focussed on the development of the conceptual model for JFS, whereas Stage 1B concentrated on using this model to ‘filter’ the relevant AAM processes and information categories. Subsequently, during Stage 2 the aggregate model of the ‘JFS system served’ was used to develop a JFS BISA or ‘serving system’ model. In collaboration with requirements staff and operational users those processes of the aggregate model were identified which would require automation (or IT support). Throughout the modelling activity, the project office has independently of the modelling activity together with the potential users developed a first version of a user requirements document. As will be explained below, following the application coherence method the conceptual and aggregate models could be used to validate these requirements.

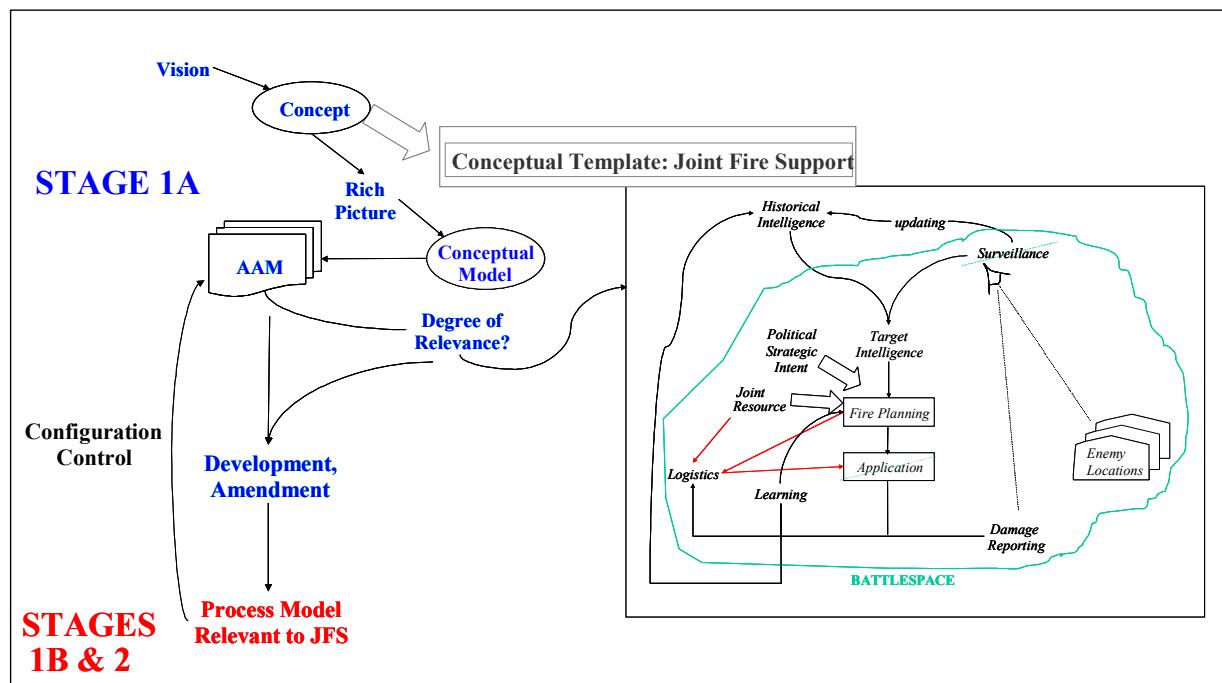


Figure 10: Stage 1A, 1B and 2 Activities.

#### 4.2 Application Coherence and User Requirements Validation

The JFS example illustrates how the principles of the application coherence method could be used for the early stages of system design. Firstly, activities concentrated on defining ‘what’ JFS was taken to be, and its coherent definition was ensured through the use of the Army Activity Model. Secondly, based on the answers to the ‘what-question’, i.e. the definition of the served system, it was determined ‘how’ this system will be supported by an Information System, i.e. the serving system. Although, ideally URs should be based on the process and information needs of the Army as captured in the business model, i.e. the AAM, for the UK Army’s digitisation programme or the business area related conceptual model, as for JFS, often this does not occur. Because the AAM had not been developed for it to be available in time, problems now exist to assess whether the current set of URs support a coherent system development. Often much effort has been expended in formulating those requirements by involving potential users and it would not be prudent to discard their views and experience.

At the higher level of the entire digitisation programme, the problem is particularly complex as different facets are described using different language (conceptual, real world). It is very likely that the URs, although structured are not coherent<sup>5</sup>. Moreover, the digitisation programme has not been underpinned by a set of logical models which has now become available through the development of AAM, preparation for application coherence assessment, et al. Consequently, URs have been specified without logical structure and defensible scope. Finally, there are no agreed definitions of scope and capability for the various business areas which could serve as a high-level structure for all URs.

To ensure that development of the IS occurs coherently while meeting the URs, the URs should reflect the Army’s new business processes, which are found in the AAM or extensions to it. In principle, it is possible to identify the set of activities in the AAM and their information dependencies that represent the

<sup>5</sup> Requirements are grouped into a section for each BISA; Each BISA records requirements using a different structure and to varying degrees on detail/completeness, requirements have not been normalised.

capabilities needed (“what needs to be done”) for a given business area. However, it is probable that certain activities of the AAM may have been specified at too high a level to be of immediate use.

As has been explained earlier, mapping of functional areas to appropriate activities in the AAM has occurred. However these types, based on staff functions, bear no resemblance to the business areas used in the structure of existing URs. Consequently, business area boundaries need to be derived rather than immediately mapped. A complimentary view of the capabilities required for the digitisation programme is that provided by the set of URs.

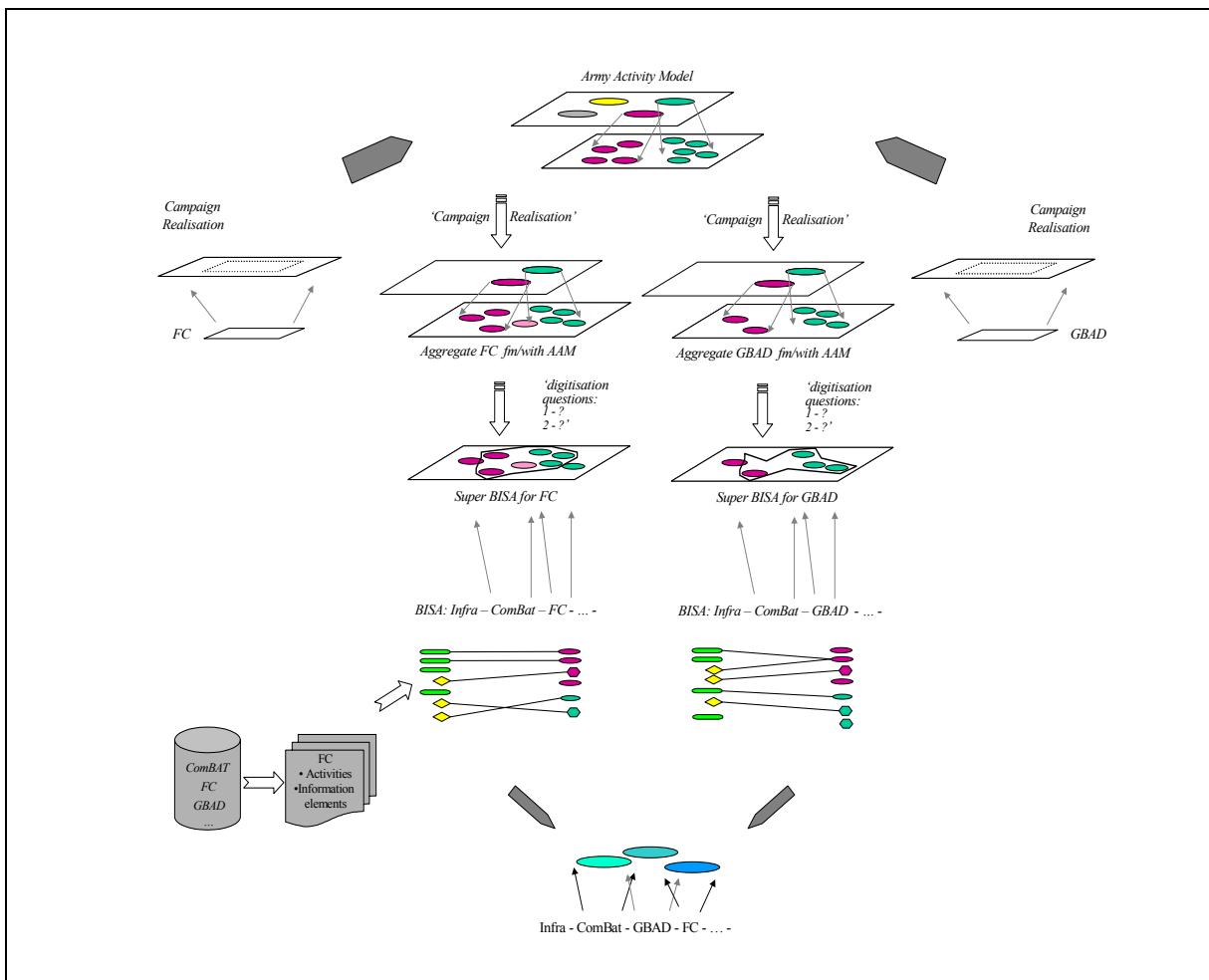
The UK digitisation programme is based on the development of distinct Battlefield Information System Applications (BISAs) to support particular business areas (e.g., JFS BISA), whereas common BISAs will be developed to support those processes which are – more or less – shared Army-wide (e.g., Common Battlefield Application Tool – COMBAT). An important aim of the digitisation programme is that certain BISAs, or their constituent tools (i.e., Battlefield Information System Tools – BISTs) will be available for implementation across the Army business areas, which will prevent duplication of development effort and which in turn should support coherent development. The BISAs and BISTs are defined in a catalogue for which a set of ‘functional area’ process models has been built during its development. Like the AAM these models, one for each business area, define process and information. The models have been analysed to identify where, in the judgement of the analyst, tools (potential BISTs) may support business processes. Subsequently, BIST definitions are provided based on data flow diagrams of the tool processes. Unfortunately only a few of the business areas completed this analysis. The remainder, through business area subject matter experts, made no distinction between business processes and tool processes to support the appropriate subset of those business processes. Hence, the content of the BISA catalogue is of varying quality. The catalogue does contain a reasonable structure for the set of BISTs. A method has now been developed to improve consistency and coherence across the full range of URs. The method has been based on the applications coherence method described earlier.

In addition to the aforementioned model development process described for JFS (i.e. conceptual model, and aggregate model), analysis now focuses on how URs relate to the processes and information elements of the model. Firstly, the URs needs to be analysed and ambiguities removed after which information elements (IE) are derived for these URs. These IEs are mapped onto or translated into ICs or IP definition as appropriate, so that tools (ICAT<sup>6</sup>) could be used to manipulate information and compare against a coherent reference taxonomy.

Figure 11 shows how for a particular business area, the URs from that business area are then compared with the related activities from three core projects (i.e. COMBAT, Platform and Infrastructure BISAs) by deciding what activities those URs relate to in the “Super BISA”<sup>7</sup> model. The three core projects are likely to have a high degree of relevance to most business areas and the analysis is performed to detect gaps and overlaps with the business area BISA. Any relevance of requirements from other projects is picked up at stage 6 of the method.

<sup>6</sup> The ICAT tool is currently being developed by Hi-Q Systems Ltd and Salamander.

<sup>7</sup> This is merely a term to describe the set of logical activities of a business area requiring BIST support, a number of which may be supported by BISTs from business areas other than the one being analysed.



**Figure 11: Method.**

Further analysis can now be completed and map UR activities and/or information elements to Super BISA activities and information categories. Different Information Products (IPs) for different business areas can map to the same process in the AAM. At lower levels of resolution the same set of IPs may map to different and more specific processes, i.e. those unique to that business area. Care must be taken when undertaking this mapping to ensure that it is done against the aggregate<sup>8</sup> models for the business area and not the AAM itself.

Finally, expert judgement is used to take the automated set of reports for all business areas that shows mappings of URs to “digitisation” activities and identify gaps<sup>9</sup>, overlaps, “reasonable” mappings and hence discuss the legitimacy of each UR<sup>10</sup>. This will require an ability to interpret the tool results by categorising most likely associations between URs and AAM activities.

<sup>8</sup> An aggregate view shows all processes and their interactions as a single flat view rather than the set of individual views generated by hierarchical decomposition.

<sup>9</sup> Gaps work in both directions: those URs with no association to models and hence illegitimate and “digitisation” activities in models that have no URs that therefore require URs to be written.

<sup>10</sup> The sort of expert and the criteria for “reasonable” mapping will need to be defined during the follow on project.

Comparison across programmes, e.g., Joint Fire Support BISA, Fire Control BISA and GBAD BISA, will also lead to a better informed, higher level view and assessment of coherent development at an organisational level. A more detailed insight in the overlaps and gaps between programmes can be visualised while the programmes are still in the requirement definition or design phases, and adjustments are likely to be less costly.

## **5.0 CONCLUSION: APPLICATION COHERENCE AND THE COBP**

The NATO COBP highlights that it does not provide guidance on the development and design of new systems. Therefore, the specific use of the application coherence assessment method as addressed in this paper, cannot be contrasted against the COBP. However, as has been explained in this paper current methods still fail to support user needs and do not address information requirements appropriately. The application coherence assessment method overcomes this shortfall. Not only does it support the assessment of the degree to which existing information systems support business processes, but it also enables the development of new systems in a coherent manner.

Many of the information aspects are being addressed during the requirements and design stages of a particular C2 information system programme. Moreover, the candidate system is being assessed in a larger context and hence is being considered as part of the larger information enterprise. In addition to the coherence assessment at informatics level a more technically focussed assessment could be conducted determining the coherency of a new systems as part of the larger system-of-systems with a greater level of detail.

In contrast to many other methods and techniques, the application coherence method embraces human and organisational aspects throughout. Therefore, a more complete foundation has been created on the basis of which subsequent analysis could be conducted, e.g., through more traditional forms of operational analysis as described in the COBP. Moreover, since the application coherence method is information focussed it envisages the creation of an information enterprise that is required to achieve the objectives of information superiority.

It has been illustrated that the application coherence method enables the assessment of the effectiveness of potential systems to commence during their inception rather than upon completion when also the challenges for analysts are disparate and come in large quantities. Moreover, early insight into the degree of potential effectiveness would enable decision-makers to plan alterations and improvements when financial consequences are still minimal and system changes easier to achieve. The application coherence assessment method discussed in this paper does not conflict with the COBP, instead it should be seen as a complimentary method which could take away some of the burden experienced with operational analysis.

## **6.0 ACKNOWLEDGEMENTS**

Firstly, I would like to thank Charlie Lane for his thorough review of earlier versions and his creative suggestions that have helped this paper to evolve. Secondly, I thank Jeremy Barrett for allowing me to use his paper on the application coherence assessment method, and his critical reflections that have been of crucial significance to the effective application of the coherence method.

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## 8.0 LIST OF ACRONYMS

AAM	Army Activity Model
BISA	Battlefield Information System Application
BIST	Battlefield Information System Tool
C2	Command and Control
C2IS	Command and Control Information System
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CM	Conceptual Model
COBP	Code of Best Practice
COMBAT	Common Battlefield Application Tool
FA	Functional Area

FC	Fire Control
GBAD	Ground Based Air Defence
IC	Information Category
IP	Information Products
IS	Information System
IT	Information Technology
JFS	Joint Fire Support
ORBAT	Order of Battle
RW	Real World
RWA	Real World Activity
SSM	Soft System Methodology
UK	United Kingdom
UR	User Requirements
URD	User Requirements Document

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**Kees van Haperen MSc MICDSS MBCI** is a Senior Consultant with Hi-Q Systems Ltd specialised in military C2IS and (SSM) process and information modelling. As a former Fighter Controller with the Royal Netherlands Air Force, he has specialised in C2, interoperability and tactical data communications. He has been working in the UK since 1996 and has been involved in the development of national and international operational concepts and procedures, a large number of national and international air force, navy and army platform and system programmes, e.g., NATO ACCS, the Australian Air Defence System Vigilare, German Tiger Helicopter and tactical data link implementations in various UK platforms (TACC, Nimrod, Tornado ADV, GRAP IOC, etc.). In 2000, he completed a Masters degree in Risk, Crisis and Disaster Management, which has enabled him to include the ‘softer’ aspects of C2, in particular those related to crisis management and team decision-making under stress. More recently, he has been focussing on the development of conceptual models and information architectures in support of several BISAs of the UK Army’s digitisation programme. He has published several scientific papers on risk and crisis management and the use of simulation exercises for crisis management.

# Working Towards Information Superiority: Application Coherence for Digitisation Programmes

*A Method for Coherently Defining Requirements for  
Future Command and Control Information Systems*

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# Overview

- **Introduction**
- **Answering the Challenges of Digitisation**
  - The Information Age
  - The Need for a Different Approach
  - Soft Systems Methodology
- **Application Coherence Method**
- **The Method for New Programmes**
  - Case Study 1: Joint Fire Support Battlefield Information System Application
  - Case Study 2: User Requirements Validation
- **Conclusion: Application Coherence and the COBP**

- **Danger of misalignment between applications and the businesses they purport to support**
- **Through lack of strategic direction there is a risk that bespoke and stovepipe IS development will continue**
- **Concern that there is a potential lack of coherence across and within Battlefield IS programmes**
- **Results:**
  - Inability to transfer data and information effectively between battlefield applications
  - Degrade the ability to exploit information impede the achievement of Information Superiority

# Answering the Challenges of Digitisation 1

- **Information Age**
  - ‘Transforming armed forces into smoothly operating synchronised systems’
  - ‘Friction of warfare ameliorated by effective acquisition and transmission of information transformed into command knowledge’
  - Information Superiority: ‘ensuring that peacekeepers and warfighters receive the right info at the right time to optimally influence the outcome’
- **However ...**

# Answering the Challenges of Digitisation 2

- **The need for a different approach**
  - Information = contradictory, incorrect and dubious
  - Underload and overload
  - Organisations: traditional engineering views
  - Unintended consequences: organisational and human origins
  - Various elements interact and effect change mutually in ways which cannot be predicted beforehand
  - ‘How’ versus ‘What’
  - Complex environment, complex requirements constantly striving for perfection

- **Soft Systems Methodology**

- offers a way to make sense of complicated problems
- adopts an information centric stance including human issues from the outset
- a method for resolving problems and assists in understanding the many simultaneous views which may exist on what an organisation is trying to achieve
- allows potential interfaces to a system and factors that influence system implementation to be investigated thoroughly.
- particular useful where business requirements are unclear, conflicting interests exist, or the proposed system is contentious
- may be applied to good effect where changes to business processes or organisational structure are likely

# Answering the Challenges of Digitisation 4

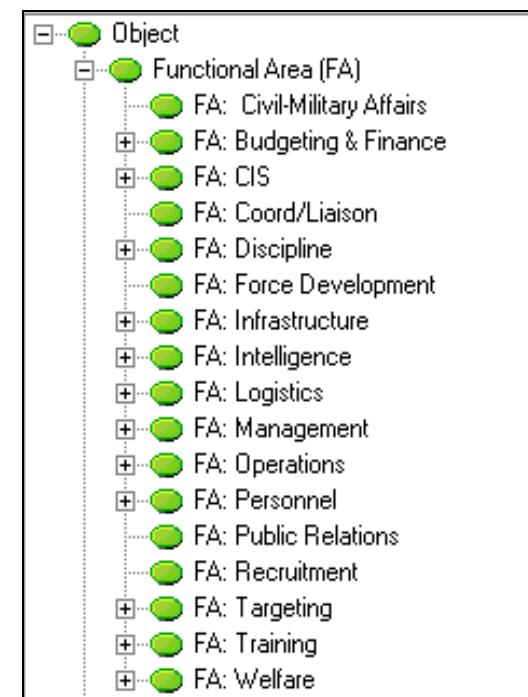
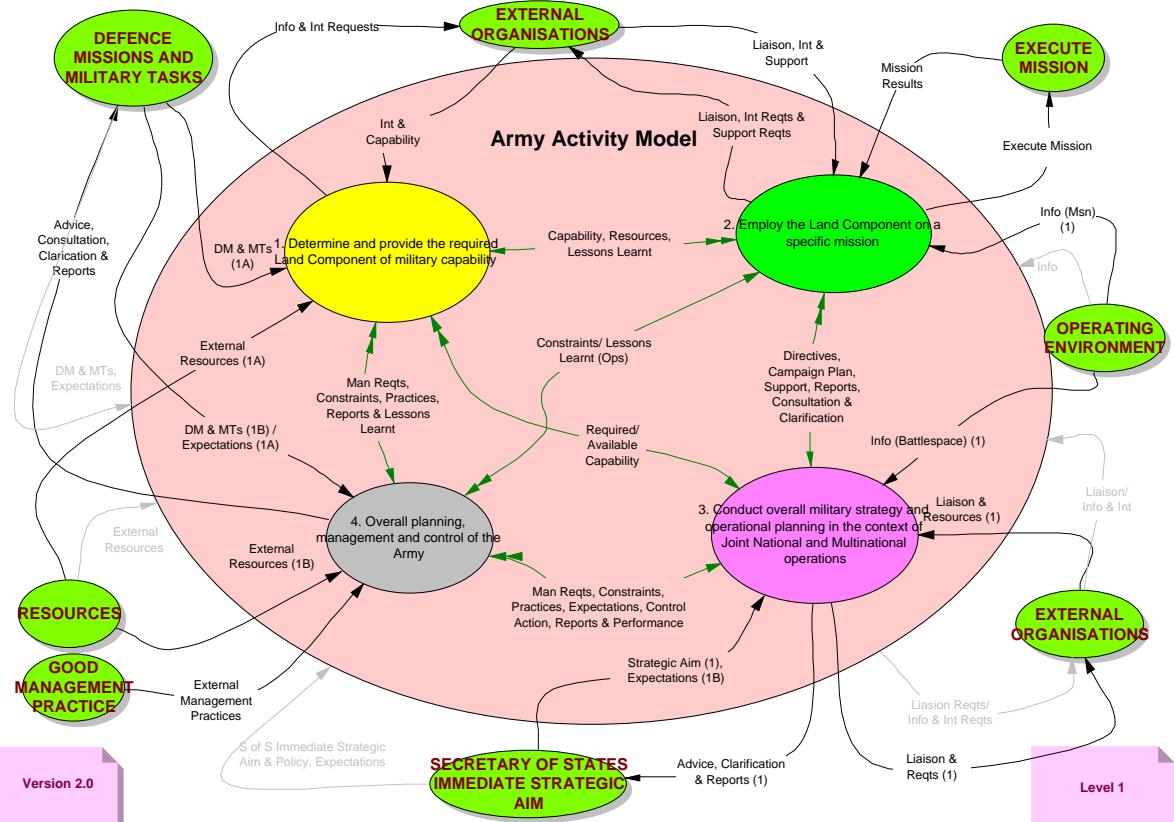
- **Soft Systems Methodology**

- based on the premise that information systems exist to serve and support people taking purposeful action
  - purposeful action can be expressed via activity models (Human Activity Systems)
  - offers a process through which an organisation can continually reflect upon its aspirations and tasks, thus continually reviewing its information strategy
  - using the methods of SSM activity systems could be modelled and the models used in a design mode to ensure that processes are institutionalised by means which the organisation would continue to learn from its flow of experience
    - See Wilson, 2001; Checkland and Holwell, 1998; Checkland and Scholes, 1999

## Application Coherence

- Poor alignment between processes and the supporting applications and little coherence between the numerous planned and in-service information.
- Developing and maintaining an information view of processes, applications and their inter-relationship.
- The starting point is to take a view of the Army 'business' and divide that into a coherent set of 'business areas'.
- Coherent view of process is traditionally delivered through an integrated business model

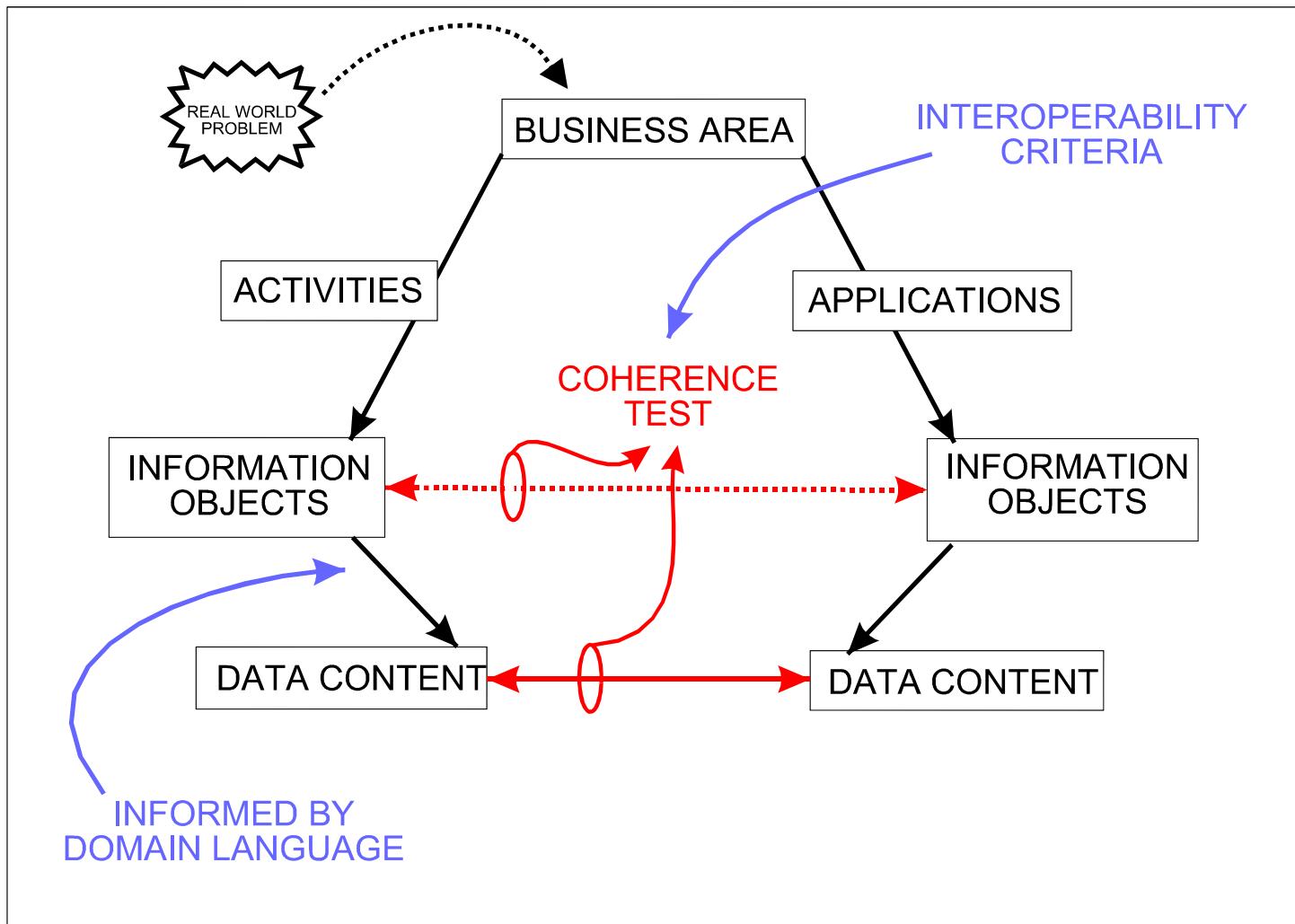
# Application Coherence



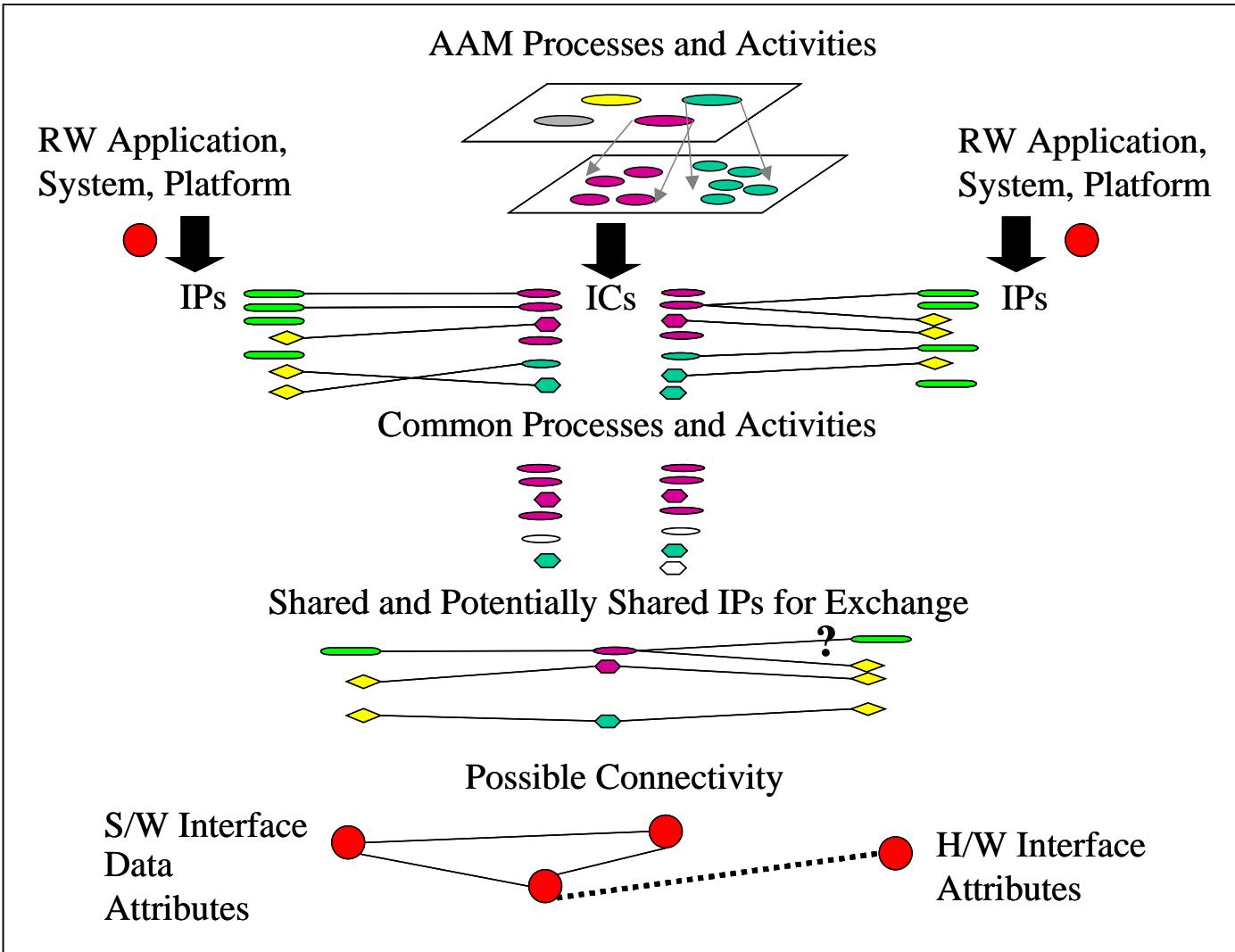
## Application Coherence

- **Coherence is about synergy and is manifest in the identification of gaps and overlaps in target systems.**
- **Information driven analysis will identify these, both in the information available to support processes, and in the ability of applications to support information requirements.**
- **Gaps and overlaps in application coverage, individually or in sets, will also be evident.**

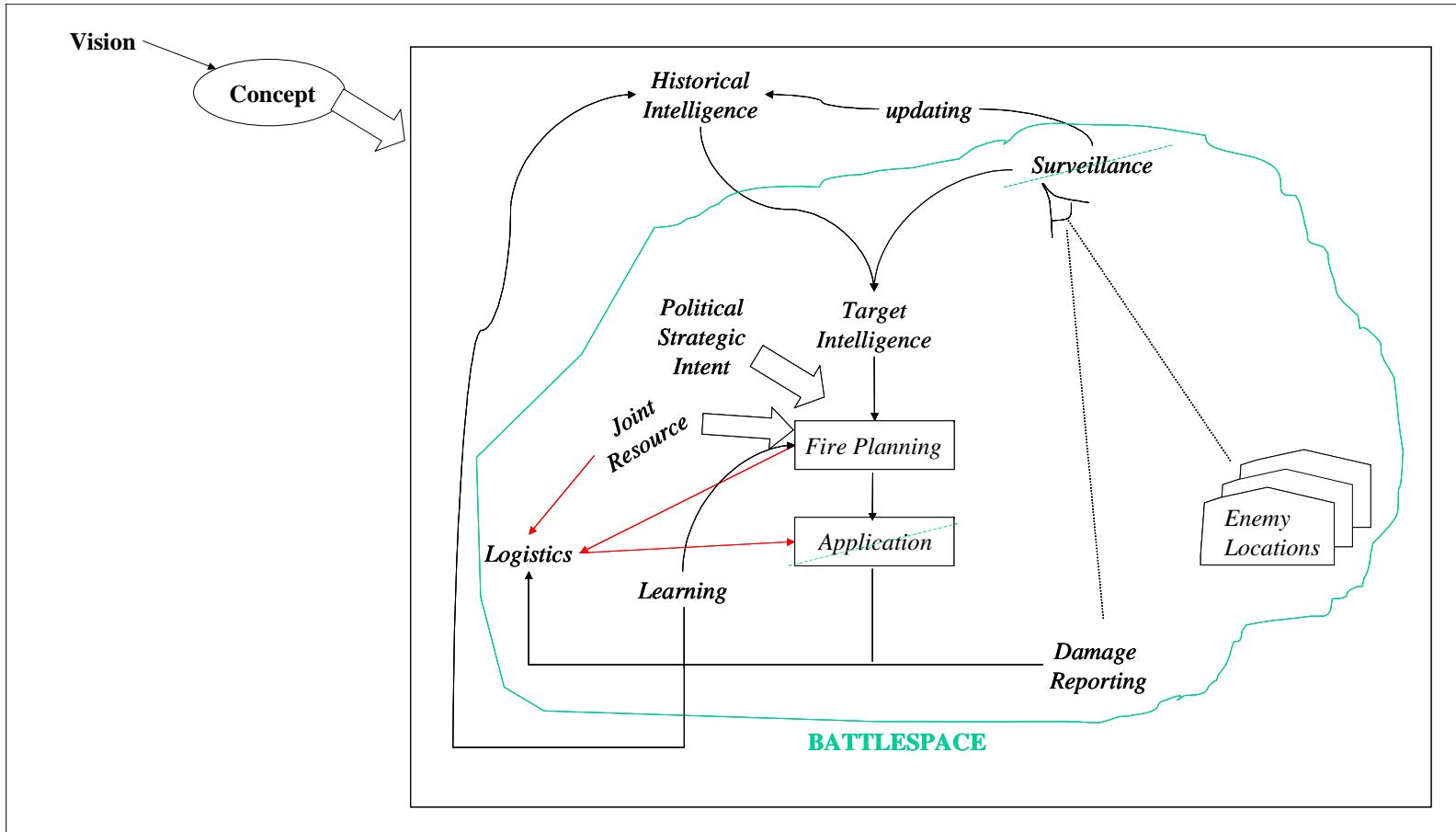
# Application Coherence



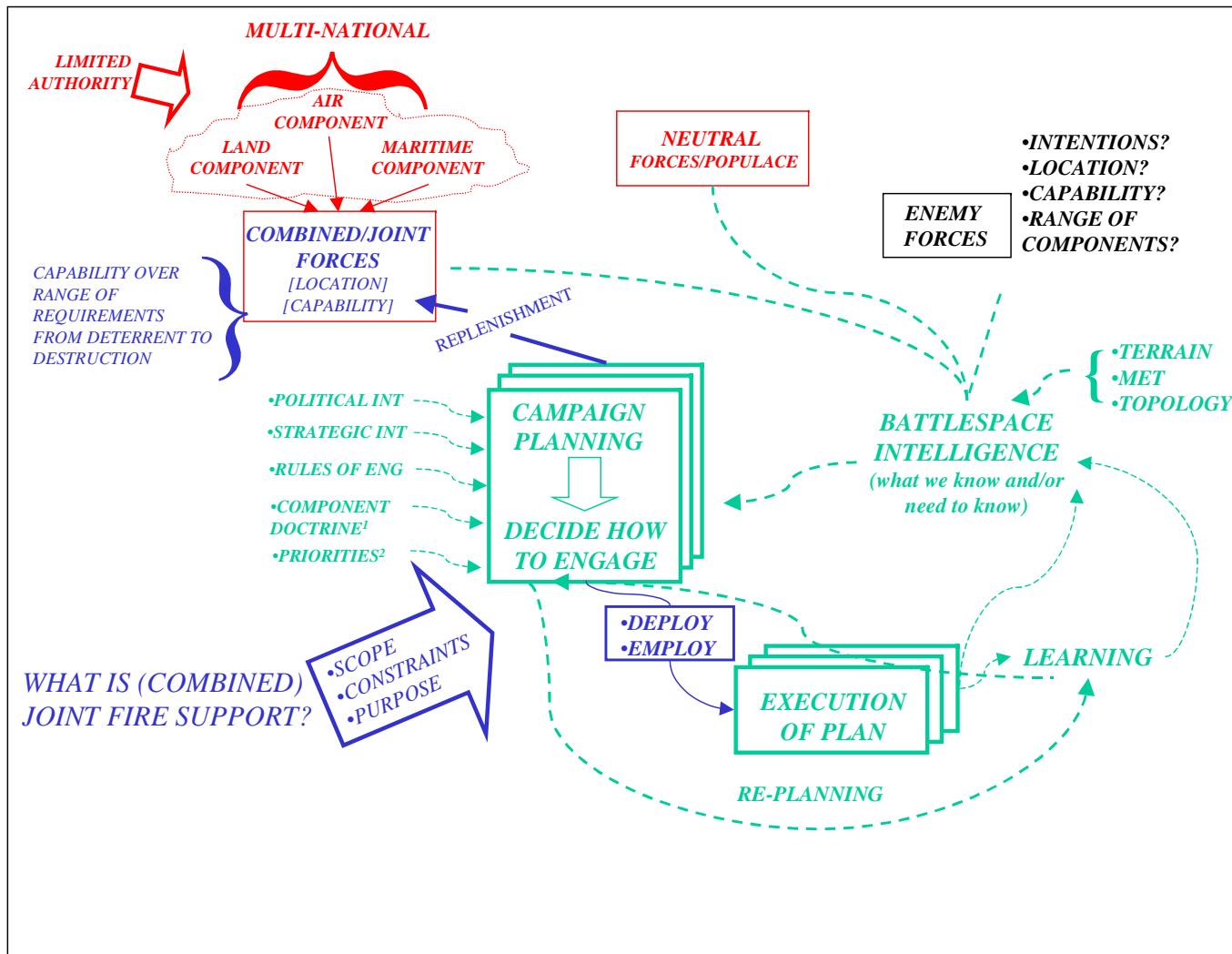
# Coherence at Different Levels



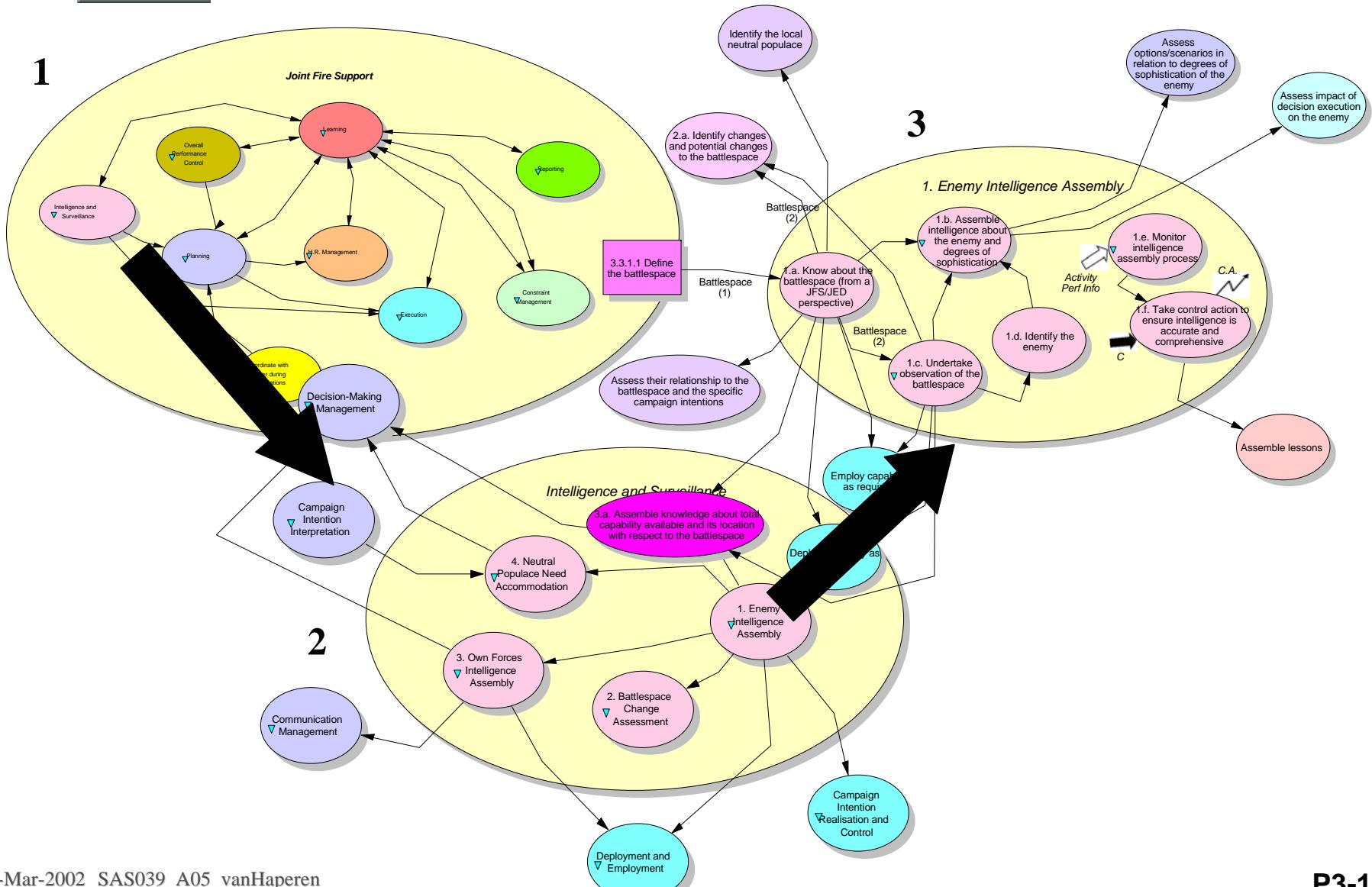
# Joint Fire Support BISA Case Study



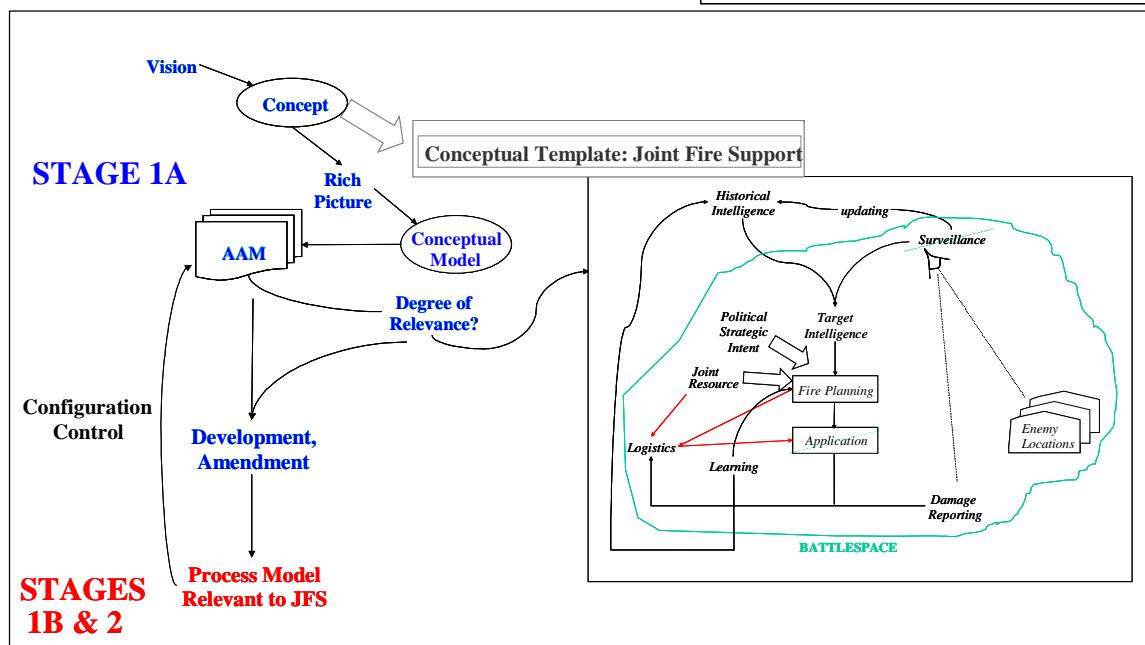
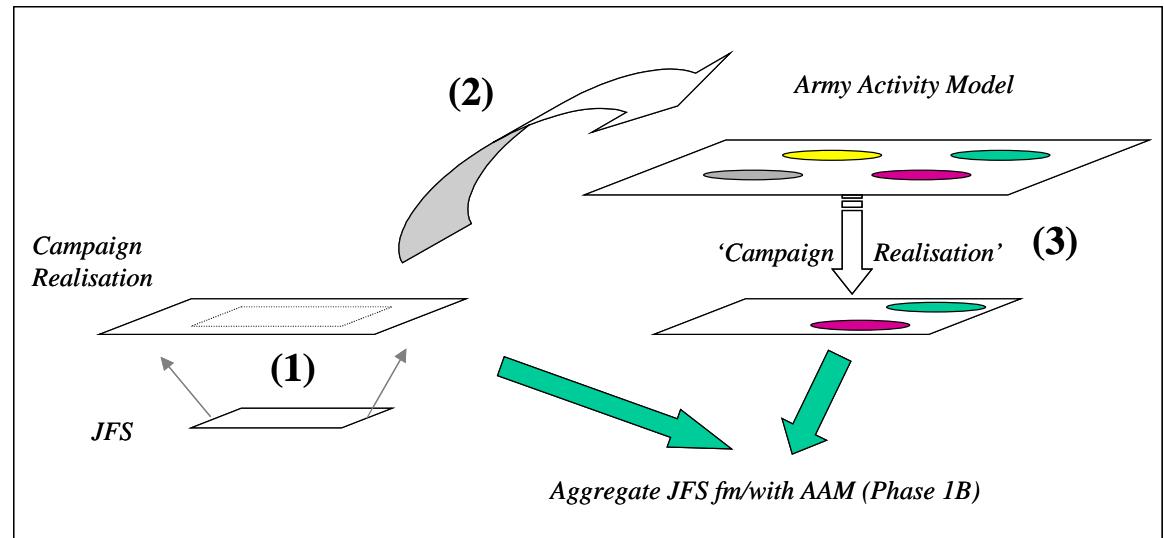
# Joint Fire Support BISA Case Study



# Joint Fire Support BISA Case Study



# Joint Fire Support BISA Case Study



# User Requirements Validation

*Campaign Realisation*

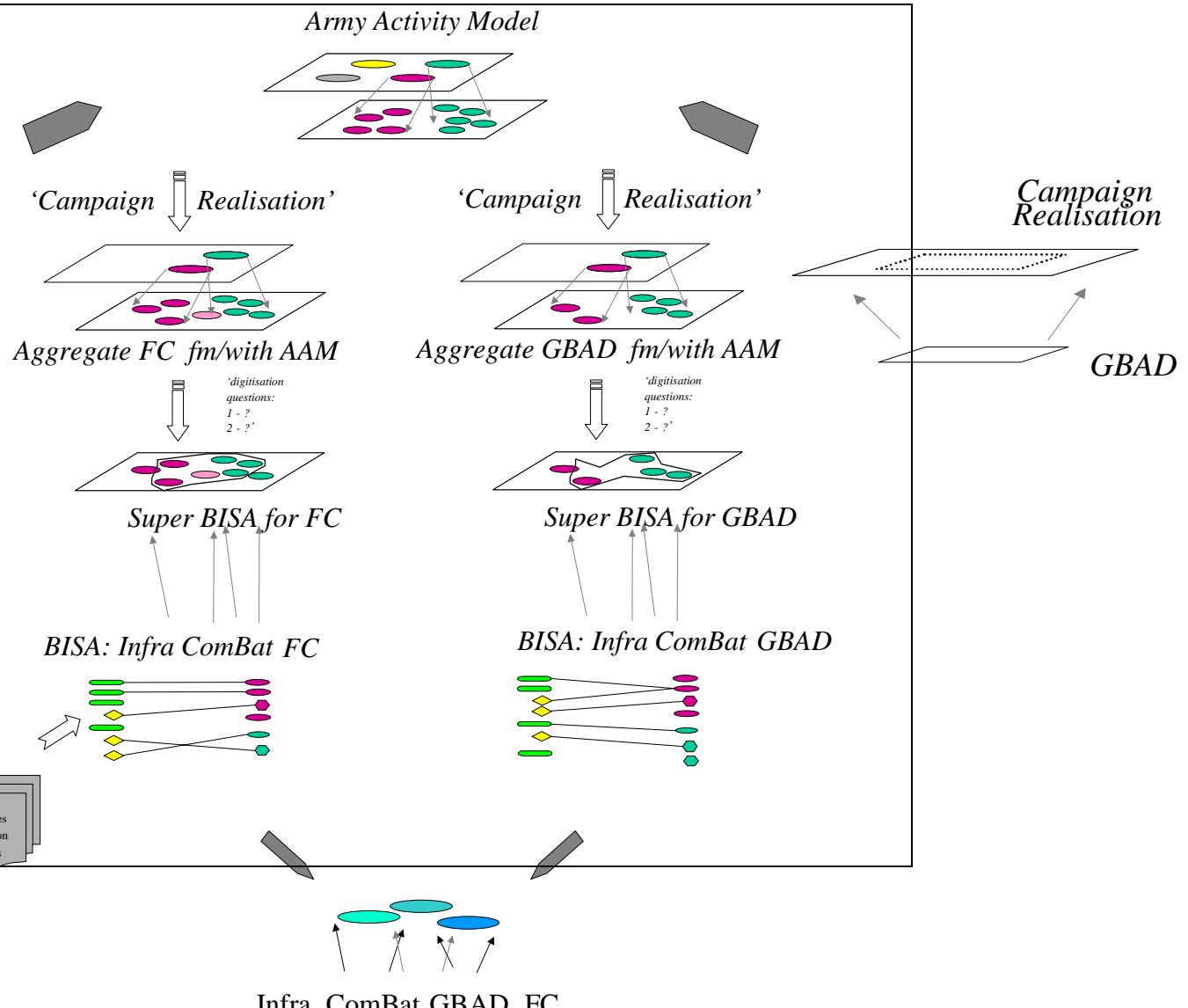
*FC*

*ComBAT*

*FC*

*GBAD*

*...*



# Application Coherence vs COBP

- **NATO COBP ≠ guidance on the development and design of new systems.**
- **Bit: Current methods still fail to support user needs and do not address information requirements appropriately.**
- **Application coherence assessment method overcomes this shortfall**
  - Support the assessment of the degree to which existing information systems support business processes.
  - Enables the development of new systems in a coherent manner.
- **Information aspects addressed during the requirements and design stages.**
- **Candidate system assessed in a larger context and hence is being considered as part of the larger information enterprise.**
- **In addition a more technically focussed assessment could be conducted determining the coherency of a new system as part of the larger system-of-systems with a greater level of detail.**

# Application Coherence Benefits-1

- A coherent, defensible view to deliver strategic objective(s) in terms of a coherent set of processes, linkages and supporting information
- Coherency:
  - Ensuring that new applications support the business processes
  - Assessing the extent to which existing systems support the business processes
  - Integrating new and existing systems into a coherent architecture

# Application Coherence Benefits-2

- **Models act as an enduring reference framework for:**
  - Requirement derivation, validation and verification
  - Trade-off analysis
  - Boundary Issues
  - Risk Identification and Mitigation
  - Operational and Information Architectures
  - Delivery of coherent integration/incremental acquisition
- **More complete and better informed engineering framework overarching more traditional engineering methods (hard vs. soft; OOSE/OOSA)**

